

METHOD FOR PRODUCING A FIRE PROTECTION GLAZING

DESCRIPTION

5 The invention relates to a method for the production of fire protection glazing, consisting of at least two flat substrates and one transparent fire protection means, whereby the fire protection means consists of at least one film or of a film system having at least one intumescent layer, and the fire protection means is introduced between the substrates.

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 In order to produce fire protection glazing, it is a known procedure to employ intumescent materials that, within a glazing unit having at least two glass panes, form a transparent interlayer that expands in case of fire. When the layer expands, a considerable amount of energy of the occurring heat is absorbed by the water
15 contained in the layer, which causes the water to evaporate. After the evaporation of the water, a foam-like heat shield is formed which, during the further course of the fire, assumes the function of heat insulation for the glass pane that lies behind the fire protection layer as well as for a room that is to be protected.

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 It is a known procedure to use hydrogels to form such fire protection layers. The main constituent of these hydrogel layers is usually water with admixtures of salts and stabilizing polymers. Here, the stabilizing polymers serve as gel formers. Such a fire protection layer consisting of a hydrogel is described, for example, in German Patent DE 35 30 968.

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With the known methods for the production of intumescent layers for fire protection glazing, the material is applied into the glazing preferably by means of pouring or gel and by resin-casting methods in which the appropriate material is applied between two panes that are held apart from each other.

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In the case of pouring methods, the intumescent material is poured onto a pane, after which the second pane is applied over it. Such a method is described, for example, in German Preliminary Published Application DE 44 35 843. Here, a drainage protection rim made of putty is placed onto a horizontally positioned glass pane, and then a fire protection solution is poured onto the glass pane. The water of the solution is removed by means of drying processes so that the layer solidifies to form a solid fire protection layer.

Conventional pouring methods, however, have a number of drawbacks. For example, time-consuming adjustment of the glass panes is necessary in order to avoid large thickness and moisture gradients over the pane. This is a serious problem especially in the case of large panes since, generally speaking, it is very difficult to handle such glass panes. Moreover, when the applied materials are drying, non-homogeneous drying conditions occur that lead to considerable quality problems and poor fire behavior due to non-homogeneities in the chemical composition and in the resultant physical properties in the x, y and z-directions. Furthermore, the dryers used define the dimensions of the panes that can be treated so that only a very limited choice of pane sizes is possible. There are likewise limits as to how the composition of the functional material can be varied since the drying process is very sensitive. Moreover, the drying process itself is very time-consuming and difficult to regulate.

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The intumescent fire protection material can also be poured into an already joined double glass pane in which two panes are preferably positioned at a certain distance from each other by means of a frame-like holder. The interstice thus formed is
5 then filled with the appropriate material. This is described, for example, in German Preliminary Published Application DE 195 25 263.

The known gel and casting-resin methods have various drawbacks. For example, only production in the final dimensions is possible since the pouring
10 procedure can only be used with prefabricated double glazing having certain dimensions. The constructions are often very thick and heavyweight. In the case of thin layers, problems also arise in connection with the thickness tolerance over the larger dimensions. Due to the flowability of the gel, bulges are formed or even delamination between the gel and the pane can occur. A large problem is also posed
15 by the edge sealing that is necessary to delimit the area of the gel that has been poured in.

Therefore, there is a need for a method for the production of fire protection layers with which the above-mentioned disadvantages do not occur. A major improvement is the approach of producing the fire protection layers separate from the glazing
20 unit into which they are to be installed at a later point in time. German Patent DE 28 15 900, for example, discloses a method for the production of a solid layer of an intumescent material comprising hydrous or hydrated metal salts in which the fluid material is poured into a mold where it hardens.

German Patent DE 27 52 543 describes a method for the production of a light-permeable, fire-retardant glass pane with at least one solid layer made of hydrated sodium silicate, whereby the layer is sandwiched between two glass panes. The intumescent layer can be formed, for example, on the glass pane; it can be provided as
5 a film on its own, or else it can consist of several layers.

German Patent DE 35 09 249 discloses a method for the production of a transparent fire protection sheet. With this method, an aqueous solution of an expandable material is applied onto a support, this layer is dried by applying heat until
10 the residual water content ranges from 20% to 48% by weight and the expandable material thus obtained is applied as at least one layer onto at least one glazing pane.

Likewise known are fire protection means in the form of hybrid film systems in which at least one film is coated with intumescent material. Such film systems can
15 be produced, for example, by means of a continuous, cascading process in which additional films or film layers are applied onto a base film.

Such film systems typically have at least one layer having a high elasticity so that the layer system exhibits advantageous mechanical properties and can be transported, stored and processed very well. In order to simplify the introduction into
20 various environments, the film system can have at least one adhesive layer with which it can be introduced into various components of a glazing unit and can be affixed to said components.

Therefore, prefabricated fire protection films or film systems entail several advantages in comparison to conventional fire protection means. A major advantage lies, for example, in the flexible choice of the size of the fire protection glazing units that are to be produced, since the films employed can be cut into any desired size and
5 can be processed in this form. In order to be able to realize correspondingly large glazing units, however, the introduction of the fire protection films into a glazing unit calls for methods that are adapted to the new circumstances.

In the realm of the production of laminated safety glass, it is likewise a known
10 procedure to introduce functional films into glazing units. On this subject, for example, German patent applications DE 36 15 225 A1 and 100 02 277 A1 describe special methods. However, the prior-art methods are not suitable for effectively introducing fire protection films into a glazing unit, since specific requirements have to be made of safety glass and these differ from those for fire protection glazing.

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Therefore, the objective of the invention is to provide an effective method for the production of fire protection glazing comprising a fire protection means in the form of a film or of a film system. The method should be especially well-suited for the production of fire protection glazing units having a large surface area.

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According to the invention, this objective is achieved by the features of Claim

1. Advantageous embodiments of the invention are the subject matter of Claims 2 to
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With the method according to the invention for the production of fire protection glazing, the glazing unit employed consists of at least two flat substrates and one transparent fire protection means, whereby the fire protection means consists of at least one film or of a film system having at least one intumescent layer. The fire protection film is introduced between the two substrates. The method is characterized in that several film sections of the fire protection means are applied onto a first substrate, whereby the film sections cover the entire surface of the substrate that is to be provided with the fire protection means. Then a second substrate is applied onto the first substrate having the film sections and a laminating process is carried out at elevated pressure and elevated temperature.

The individual film sections are preferably applied onto the substrate in such a manner that their edges abut each other and/or overlap slightly. Here, it has proven to be advantageous to affix the film sections onto the first substrate. For this purpose, the fire protection film can be provided, for example, with an adhesive layer so that the film sections can be glued on.

Various bonding modalities can be used for the adhesive layer. For example, water-soluble organic binders such as, for example, polyvinyl alcohols, cellulose derivatives, alcohols and/or polyalcohols have proven to be advantageous. Moreover, inorganic binders such as, for example, wetting agents having different moduli and degrees of dilution, silicic sols and/or water can likewise be employed. In an especially preferred embodiment of the invention, the adhesive consists of glycerin or water or of mixtures thereof. In this case, preference is given to a mixture of approximately 85% glycerin and 15% water.

Another way to create the adhesive bond between the fire protection film and the glass substrate is to introduce the adhesive in the form of vapor. An especially preferred embodiment in this context is water vapor.

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The advantage of adhesive processes is, among other things, that, by suitably combining the film or film system, the adhesive and the substrate, it can be avoided that bubbles become trapped in this laminate. Consequently, a bubble-free and thus optically flawless laminate can be formed. For this reason, it is also advantageous to employ an adhesive bond, for example, in the form of an adhesive layer, when applying the second substrate.

Another way to avoid detrimental bubble formation is a vacuum laminate. Here, the system to be laminated is loosely laid on top of each other in a laminator. Then an evacuation process is carried out, and the possibility exists to heat up the system. Subsequently, the system is put under atmospheric pressure at an elevated temperature in order to create a bubble-free pre-laminate of the substrates with the film system. Then a laminating process is carried out at elevated pressure and elevated temperature.

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Due to the thermoplastic nature of the films employed, during the laminating process under elevated pressure and elevated temperature, the abutting edges flow together in such a way that they are no longer visible in the finished product. Consequently, a homogeneous, transparent fire protection layer is formed over the entire

surface of the fire protection glazing. The envisaged fire protection effect is also ensured over the entire surface.

The method according to the invention has the essential advantage that fire protection glazing having a large surface area can be produced. Hence, in order to produce a unit having, for example, the standard dimensions used in the glass industry, namely, 3.21 m \times 6.00 m, it is not necessary to use a fire protection film in this size, which would lead to problems during the handling and the fixation procedure. Rather, it is possible to cover the entire surface with individual film sections without impairing the quality of the fire protection layer that is to be produced. Thus, fire protection glazing having a large surface area can be produced in a simple manner. Fire protection glazing having a large surface area, in turn, has the advantage that smaller units of any desired dimension and shape can be cut from it.

In an especially preferred embodiment of the invention, the pressure during the laminating process is in the order of magnitude of 1 bar to 10 bar. In order to prevent the foaming effect of the fire protection film that acts as a fire protection from already becoming active during the production process, the temperature during the laminating process has to lie below the foaming temperature of the fire protection means. However, in order to achieve a melting of the film sections, the temperature has to lie within the thermoplastic range of the fire protection means.

Additional advantages, special features and advantageous refinements of the invention ensue from the subordinate claims and from the presentation of preferred embodiments given below.

In an especially preferred embodiment of the method according to the invention, in order to produce fire protection glazing, a film or film system is introduced between two glass panes. A hybrid fire protection film is used as the fire protection means. This film preferably consists of several layers, at least one of which is intumescent. In another especially preferred embodiment of the invention, the layer structure is supplemented by a third substrate.

A hybrid film system can be produced, for example, by means of a continuous, cascading method in which, first of all, a film or film layer is applied and another film or film layer is applied thereupon, as well as optionally another film or films and/or film layer or layers is/are applied. At least two of these film layers have different chemical compositions, and at least one of the film layers is fire-retardant.

The term fire-retardant as employed in the sense of the invention is defined as a layer or film that is capable of absorbing the energy of a fire in order to protect structural components or building sections located behind said layer or film.

In order to enhance the mechanical properties of the fire protection means, it is advantageous for the film system to have at least one layer having a high elasticity. Moreover, in order to simplify the application into various environments, it has been proven to be advantageous for the film system to have at least one adhesive layer that serves for the introduction into environments.

An especially advantageous embodiment of the invention is characterized in that at least one constituent of the film system has a siliceous base. This has the advantage that high fire resistance as well as good mechanical properties can be achieved. Thanks to the use of a siliceous base, the desired elasticity of the fire
5 protection means can be achieved already at relatively low contents of organic additives.

The variation of different properties within a single layer that can be laminated, for example, as a film, has the advantage that this makes the fire protection
10 means easier to produce. Moreover, this makes it possible to achieve a high degree of transparency, assuming a low absorption in the visible spectrum.

The constituents can be varied in the case of a single layer as well as in the case of several layers that differ from each other.
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In order to produce fire protection glazing using the method according to the invention, several film sections of the fire protection means are applied onto a first substrate. The substrate is typically a glass pane, but other substrate materials can also be used. With the method according to the invention, in particular, fire protection
20 units having a large surface area can be produced so that the dimensions of the substrate can be, for example, in the order of magnitude of the industrial standard dimensions, namely, width $W = 3.21 \text{ m}$ \times length $L = 6.00 \text{ m}$. However, larger or smaller substrates can also be used.

The glass pane can have already been pretreated in various process steps that are necessary or advantageous for the production of a desired glazing unit. For example, functional layers can be applied that influence the transmission of the glazing unit that is to be produced.

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On the first substrate, those areas that are to receive a fire protection layer are covered with film sections. The individual film sections can either be manufactured in the desired size or can be cut from a film having a large surface area. Making it from a film having a large surface area has the advantage that sections having any desired surface area can be cut out.

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It has proven to be especially advantageous for the fire protection film to have an adhesive layer on at least one side so that the film sections can easily be applied onto the first substrate and affixed thereto. The adhesion force of the adhesive layers employed can advantageously be adjusted so that an adaptation can be made to various surrounding materials such as glass, plastic or the like.

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In an especially preferred embodiment of the invention, the film sections are applied onto the substrate in such a way that their edges abut each other and/or overlap slightly. During the laminating process that is carried out in order to fuse the film sections, these sections bond together in such a way that the abutting edges can no longer be seen and the appearance of the glazing produced by means of the production method according to the invention is not impaired.

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According to the invention, a second substrate is applied onto the first substrate having the film sections. This section can also have already been pretreated in various process steps. These possible process steps also include further functional layers. Moreover, additional layers can be applied onto the film sections before the second substrate is applied onto the first substrate. The second substrate is preferably applied by affixing the substrates among each other. Here, for example, mechanical bonds or adhesions can be used.

In order to create a bubble-free laminate, the substrate laminate can also be produced as a vacuum laminate. Here, the system of layers to be bonded is loosely laid on top of each other in a laminator and subsequently evacuated. Then the system is preferably charged at atmospheric pressure at an elevated temperature and in this manner, a bubble-free pre-laminate is produced that can now undergo the actual laminating process.

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In order to fuse the individual film sections with each other, the layer structure undergoes a laminating process at an elevated pressure and elevated temperature. This laminating process can be carried out in a device such as, for example, an autoclave. The duration of the laminating process is preferably in the order of magnitude of 3 to 6 hours. In an especially preferred embodiment of the invention, the laminating process takes 4 hours. This includes, for example, a heating phase of about one hour, a retention phase of about two hours and a cooling phase of about one hour.

In order to fuse the film sections, the temperature during the laminating process has to lie within the thermoplastic range. So that the fire protection means

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does not already become active and expand during the production process of the glazing, however, the temperature employed has to lie below the foaming temperature of the fire protection means. It has proven to be advantageous to select a temperature that is approximately 10°C to 20°C [18°F to 36°F] below the foaming temperature of the particular fire protection means. It has proven to be advantageous for the temperature to be at least 70°C [158°F]. Maximum temperatures of 150°C [302°F] have proven to be especially advantageous. In a particularly preferred embodiment of the invention, the temperature is in the order of magnitude of 80°C to 100°C [176°F to 212°F].

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The pressure during the laminating process is preferably in the order of magnitude of 1 bar to 10 bar. In an especially preferred embodiment of the invention, the pressure is 1 bar to 2 bar.

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During the laminating process, the film sections fuse with each other without abutting edges, between the sections being visible, and the finished product has a homogenous transparent fire protection layer. Moreover, the fire protection effect is ensured over the entire surface.